Biliary complications after orthotopic liver transplantation: diagnosis with MR cholangiography and MR imaging at 3T-device

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Aims and objectives

Orthotopic liver transplantation (OLT) has become the treatment of choice for end-stage liver disease, as well as for severe acute liver failure and in the last years the number of transplants is progressively increased. Despite the enormous improvement in post-OLT survival over the years, adverse events of the biliary tract, which occur in 5% to 32% of adult liver transplant recipients, are one of the most important reasons for morbidity, graft loss, and mortality of liver recipients. Adverse events such as bile leaks, anastomotic and non-anastomotic strictures, biliary stones, sludge and casts are encountered more commonly as a result of increased number of liver transplantations and the prolonged survival of transplant patients. Early adverse events are those occurring within three months, whereas the late ones can be observed a few months to several years after OLT.

Various authors have already reported good results concerning the use of MR cholangiography (MRC) in the detection of biliary complications in liver transplanted patients, and we have been routinely using this technique as a mean of imaging the biliary tract in transplanted patients.

The purpose of our exhibit was to assess the diagnostic value of MR cholangiography (MRC) and MR imaging at 3T-device when evaluating biliary complications after orthotopic liver transplantation.

Methods and materials

A series of 116 transplant subjects with suspected biliary complications (impaired liver function tests and/or biliary abnormalities on ultrasound) underwent MRI at 3T device (GE-DISCOVERY MR750; GE Healthcare, Milwaukee,Wis). The 8-channel phased-array body coil was used for both excitation and signal reception.

Ten minutes before MRI, a super-paramagnetic suspension (Lumirem® 50 ml, Guerbet) was orally administered to suppress the signal intensity of overlapping fluid-containing organs and in an attempt to improve the visualization of the duodenum. Scopolamine methyl-bromide (Buscopan® 20 mg/ml, Boehringer Ingelheim) was intramuscularly administered immediately before starting the examination in order to avoid peristaltic artefacts.

MR study protocol:

- 3D breath-hold T1w GRE sequence (SPGR/LAVA flex) with and/or without fat suppression, both in phase and out of phase, at the liver level, 3-5 mm thickness;
- T2w sequences (FSE Propeller with respiratory-triggered and breath-hold single-shot FSE) with and/or without fat suppression at the liver level, 5-6 mm thickness with an interval of 1-2 mm;

- cholangio-pancreatographic T2w sequences (respiratory-triggered, 1-2 mm thin-slab, 3D-FRFSE and breath-hold, 10/50 mm thick-slab, SS-FSE) in the different spatial orientations (coronal and coronal-oblique planes);

- DW sequences (single-shot spin-echo echo-planar imaging) in the transverse plain, using multiple b-values (0, 150, 500, 1000, 1500 sec/mm²) in all diffusion directions (slice section 5-6 mm, spacing 0.5-1.5 mm, nex 4).

Maximum intensity projections (MIPs), volume rendering (VR), multiplanar reformatting techniques were applied to the acquired data set of coronal thin-slab T2-weighted FRFSE on an independent workstation (Advantage Windows 4.5; GE Healthcare, Milwaukee, Wis).

All MR images were blindly evaluated by two experienced abdominal radiologists in conference who were blinded to patient identification and all clinical, laboratory, and previous imaging findings; differences in interpretation were settled by means of consensus.

The observers determined the presence of biliary complications, whose final diagnosis was based on direct cholangiography, surgery and integrating clinical follow-up with ultrasound and/or MR findings.

**Results**

In twenty-four patients no biliary abnormality was observed. The remaining ninety-two subjects were affected by one or more of the following complications: ischemic-type biliary lesions (n=42), anastomotic strictures (n=20), ampullary dysfunction (n=18), anastomotic leakage (n=2), stones, sludge and casts (n=36) [Figure 1A, 1B, Figure 2A, 2B, 2C, 2D, Figure 3A, 3B]. The sensitivity, specificity, PPV, NPV and diagnostic accuracy of the reviewers for the detection of all types of biliary complications were 99%, 91%, 98%, 95% and 97%, respectively.

**Images for this section:**
Fig. 1: Figure 1 A Ischemic-type biliary lesion in a man with abnormal liver function tests. MR cholangiograms demonstrate a stenosis of the hepatic bifurcation and hepatic ducts with an irregular dilation of the intrahepatic biliary system. Axial T1 and T2-weighted sequences well exhibit the presence of endoluminal casts and circumferential wall thickening at the level of hepatic bifurcation.
**Fig. 2:** Figure 1 B Ischemic-type biliary lesion in a man with abnormal liver function tests. On DWI areas of persistent high signal intensity can be observed in the liver parenchyma in all b-value acquisitions.
**Fig. 3:** Figure 2 A Anastomotic biliary stricture with lithiasis in a woman with biochemical parameters of cholestasis. Axial T1- and T2-weighted images show dilation of the biliary system with concomitant stones (yellow arrows).

**Fig. 4:** Figure 2 B Anastomotic biliary stricture with lithiasis in a woman with biochemical parameters of cholestasis. Maximum Intensity Projections of 3D thin-slab fast spin-echo T2-weighted images accurately depict the dilation of the both intra- and
extra-hepatic (pre- and post-anastomotic) biliary tract with a stricture of the iuxta-papillary choledocho (white arrow); the presence of two stones at the level of the hepatic bifurcation (yellow arrow) is also well appreciable.

Fig. 5: Figure 2 C Anastomotic biliary stricture with lithiasis in a woman with biochemical parameters of cholestasis. On coronal single-shot T2-weighted images (at different levels) is also better appreciable a stricture at the anastomotic site (red arrow).

Fig. 6: Figure 2 D Anastomotic biliary stricture with lithiasis in a woman with biochemical parameters of cholestasis. Endoscopic retrograde cholangiography confirms the presence of strictures and stones in the pre-anastomotic biliary tract. Stones were endoscopically removed and strictures were treated by stenting as shown on different projection images.
**Fig. 7:** Figure 3 A Anastomotic leak in a patient with hepatico-jejunostomy. Single-shot thick-slab MR cholangiogram and coronal T2-weighted images (at different levels) show circumscribed sub-hepatic fluid collections with thickened walls in the area of biliary-enteric anastomosis,
**Fig. 8:** Figure 3 B Anastomotic leak in a patient with hepatico-jejunostomy. Gd-EOB-DTPA enhanced LAVA T1-weighted images and MIP reconstruction, obtained 30 and 60 minutes after contrast agent administration, well exhibit extravasation of contrast material into the peri-anastomotic space compatible with bile leakage. On axial and coronal post-contrast LAVA images it is possible to distinguish the fluid collection (red arrow) from the jejunum (white arrow).
Conclusion

As a non-invasive and accurate alternative to direct cholangiography, MR cholangiography represents the next step in the event that ultrasound does not reveal evidence of bile duct abnormalities despite clinical suspicion, and actually plays a crucial role in the assessment of biliary abnormalities after surgery. Although various modifications of this technique have been recently proposed, they all require the acquisition of a heavily T2-weighted sequence, which allows to visualize the structures containing stationary or slow-moving fluids as very hyperintense areas. The quality of MRC has been significantly improved with the recent introduction of multiple three-dimensional (3D) pulse sequences and also the recent advent of 3T MRI could improve the diagnostic accuracy of this technique.

Very encouraging results have been reported by different authors as concerns as the MRC evaluation of biliary adverse events in patients who have undergone OLT. In a recent meta-analysis published by Jorgensen et al., the authors concluded that using MRCP we can obtain an excellent diagnostic accuracy for biliary obstruction in liver transplant patients, with a combined sensitivity and specificity of 96% and 94%, respectively. On the basis of their data they also suggested that MRCP may be a suitable test in recipients having low to moderate suspicion for biliary obstruction, and the employment of this non-invasive technique may prevent the unneeded possible risks of ERCP in this clinical setting. Besides, in a still more recent meta-analysis by Xu YB et al., these authors confirmed that MRCP is a highly accurate diagnostic technique for diagnosis of biliary complications and strictures in patients who have undergone OLT. The main disadvantages of conventional MRCP are that it lacks functional information and so, differentiation between obstructive and non-obstructive dilatation of the bile ducts is often extremely difficult.

In our study, the diagnostic accuracy of 3T MRC and MR imaging was high in the non-invasive assessment of biliary complications in liver transplant recipients and we were able to exclude the presence of a biliary adverse event in 95% of the investigated patients.

In conclusion, MR cholangiography and MR imaging at 3T device are reliable for detecting biliary complications after orthotopic liver transplantation and should be recommended before planning any therapeutic interventions.

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